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UNIDO/IO.626
31 January 1986

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH

TRAINING COURSE ON COCONUT WOOD BUILDING

UC/RAS/84/267

Preservation of coconut stem and lumber products*

Prepared by

Felino R. Siriban
Senior Science Research Specialist**

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** Forest Products Research and Development Institute, Los Baños, Laguna, Philippines.

V.86 51134

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PRESERVATION OF COCONUT STEM AND LUMBER PRODUCTS [1/]

By

Felino R.Siriban [2/]

ABSTRACT

Coconut wood like many other forest products is very susceptible to attack by staining and decay fungi and wood boring insects and fire.

Its maximum and efficient utilization for housing, poles and posts largely depends on its effective preservation and protection from wood destroying organisms and the elements. Comprehensive research and development in these fields started in 1970 and is being vigorously pursued by the Forest Products Research and Development Institute, NSTA, (Philippines), Philippine Coconut Authority Research Center, Zamboanga City; New Zealand Forest Service; and other countries like Tonga; Fiji, Samoa and Indonesia.

Following conventional preservation standards of evaluation, field "graveyard" and service tests were established to assess the effectiveness of the wood preservatives and treatment methods used. This included the performance of the hard and soft portions of the coconut wood. Indications are that for materials tested in service above the ground, a life of 20 years can be expected while rounds and quarters in contact with the ground should have an anticipated service life of 15 years.

The types of preservatives and treatment methods appropriate for the protection and preservation of coconut lumber are discussed.

1/ Paper presented in the International Seminar on Technology of Coconut Wood Processing and Utilization of Coconut Wood as Building Material organized by the Government of Quezon Province, Philippines in cooperation with the United Architects of the Philippines, Philippine Institute of Civil Engineers, Philippine Constructors Association, United Nations Development Programme and United Nations Industrial Development Organization held in Lucena City, Quezon Province on February 20 - 22, 1985.

2/ Senior Science Research Specialist and Programme Coordinator, Utilities Construction Materials Programme, Housing and Materials Research and Development Center, Forest Products Research and Development Institute, National Science and Technology Authority College, Laguna, Philippines.

INTRODUCTION

The utilization of coconut wood as a construction material has been the subject of studies by the Forest Products Research and Industries Development Commission now Forest Products Research and Development Institute (FPRDI), National Science and Technology Authorities since 1970. Local experience has shown that untreated coconut timber is very susceptible to decay, termites and other wood borers, and that it is not generally accepted as a material for housing and other constructions. Like any non-durable timber species now widely utilized, the field of application of coconut wood can be expanded through proper preservative treatment methods.

Coconut wood like any timber species that is above or in contact with ground or water would, therefore, require preservative treatment if it is to last more than twenty years in service. The preservation required may be governed by existing standards or by the length of life required under a specified service condition.

The greatest need for preservative treatment is when the timber is in ground contact or in other high decay hazard situations. Economics and length of service life desired often dictate the type or kind of preservative treatments applied to coconut timber. Finally, it is the cost of preservation treatments for specific service life that makes it necessary to consider when treatment is advantageous rather than important.

It is recognized, however, that different preservatives and treatment methods provide varying degrees of protection when exposed to the same service condition. Present conventional pressure methods are definitely more effective than non-pressure methods. Likewise, wood preservatives of different types and origin, e.g., water-borne or oil-borne type, organic or inorganic, vary in their mechanisms of protecting wood substrates. Coconut wood substrate being a monocot compared to most timber species which are dicots may behave otherwise.

1. Reasons for Treating Timber and Other Ligno-cellulosic Materials.

The following are valid reasons for treating lumber and other ligno-cellulosic materials and the order of their importance depends on several factors, such as, abundance and properties of available timbers, availability of finance, climate and the major hazards to untreated wood in the locality.

1. Safety - To prevent injury or death due to premature timber failure of wooden structure or any part of it, deterioration is visible before it becomes dangerous. Progressive deflections and presence of fruiting bodies are some of the signs of imminent failure. It is not uncommon that people continue to use shaky staircases or bridges even though they know they are unsafe. Decay in electric poles may be undetected until they are hit by a strong wind or a passing vehicle. The consequent power interruption can have far flung effects. Hence, the probability of any of these events happening will be greatly reduced by the use of treated wood.

2. To Improve the Quality of Life - Next to food, man's greatest need is shelter. Inadequate shelter lowers his resistance to disease, affects his health and well being and reduces his efficiency as a provider and a producer. Proper preservative treatment can change this by extending the useful service life of available housing materials that will last long enough to justify putting up better houses with increased comfort, spaciousness, better light and ventilation and free from decay and insect pests. Hence, houses should be built to reduce the frequency of maintenance, thus giving the dwellers more time and energy for other productive endeavours.

3. To Secure a Loan or Mortgage to Build a House - As one's standard of living improves, the cost of building houses increases correspondingly. An average wage earner cannot save enough from his wages to buy or build a house outright. Thus, he will obtain a loan -usually a big amount amortizised over a number of years. The lending institution must be assured that the house on which they hold the mortgage does not collapse before it is paid for, otherwise the money will be lent to other more viable ventures. This means that the mortgaged property must be secured. Wood preservation is one of the best ways of assuring that the structure will last longer than the term of the loan.

4. To Economize in Construction - In the past many structures, particularly those in ground contact such as electric and telecommunications poles and bridges were designed with an allowance for decay and termite attack. When the possibility of these hazards is removed by treatment of the sapwood with a fixed preservative no such allowances need be made and savings result from the shorter growing period (plantation grown species) and lower transport and handling costs on the smaller materials.

In general, the sapwood of most hardwood timber species is susceptible to decay and insect attack. Through preservative treatment, which is not difficult or expensive, this part of the timber which is not as resistant as the heartwood can be rendered as durable as the heartwood. Without treatment this is usually rejected and wasted during timber conversion. Many species composing majority of our forests are never used for the reason of non-durability.

5. To Simplify Construction - Assuming all parts of a house or structure are made of wood, there would be no need of a specialized group other than carpenters, joiners and perhaps painters. Timber is available from local sources while cement, steel and aluminum may have to come from major commercial centers and transported to remote places. The convenience and durability of such items as nails, galvanized iron sheets, bolts is such that their advantages exceed their disadvantages by a large margin and they are often preferred to the local materials they replace.

6. To Encourage New Forms of Construction - Should a new form of housing construction or a new way of bridging a river or a scheme be introduced to a community the materials most familiar to them will be most

readily accepted, provided that it can be demonstrated that the structure will not deteriorate quickly or collapse. Properly treated wood is the material mostly likely acceptable where it is traditionally used.

7. To Save Effort - Few countries keep adequate statistics (Philippines not included) on the cost of maintenance on existing structures and the cost of replacing them in timber or other materials when they are replaced. The maintenance aspect diverts skilled labor from other activities and usually involves more labor and materials than would be required for the equivalent new construction.

8. To Provide Employment - Preservation of timber provides opportunities for productive employment at all levels from the source of the material associated with cutting, handling and treatment and finally to the professional ones of managing commercial treating plants and marketing of the treated products.

At the barrio level, a small cooperative treatment plant using non-pressure or simple techniques could serve the domestic needs in up-grading the materials used in the construction of houses, and other utilities within the barrio, at the same time providing self-satisfaction as a result of employment. If that plant could also produce materials for sale to other communities, this will generate employment and more income to its members.

9. To Increase the Value of Exports - An an initial policy, the export of logs, lumber and wood chips are essential strategies of developing countries' export programmes. However, better returns could be realized if as much processing is done before the timber leaves the country. Timber prevervation can come in if the treated product is competitive and is as good or better than the materials from other countries. The immunization of Lyctus-susceptible sapwood before export is well established (e.g. Nasipit Lumber Company) and also for the treatment of timber for the lining of shipping containers (potential market for treated lumber).

Our plywood factories are producing marine or exterior grade waterproof plywood; its market potential can never be fully realized unless it is chemically preserved.

10. To Preserve Valuable Structures - Preservation of historical structures and valuable artworks is the most difficult and complicated but rewarding. Historic houses and buildings, temples and wood arts cannot be replaced because of the materials used and craftmanship. Restoration requires the combined efforts of architects, engineers, and highly skilled craftsman who must be provided with the most modern equipment and preservation techniques. Treated timber piles usually offer the cheapest and most reliable material for supporting collapsed foundations. For instance, the lateral stability of old buildings can be restored by setting treated poles in the ground and continuing up the walls.

Structural members of large dimension are often protected from deterioration by inserting diffusing preservatives into the bored members. Anti-shrinking or bulking chemicals such as polyethylen-glycol (PEG 100) and other micro-crystalline waxes that will harden in decayed wood are generally used.

11. Conservation- In general, many countries are endowed with timber naturally resistant to biological deterioration. As a rule, these durable species are usually favoured for building houses and also to some extent for furniture.

Selection of the more abundant but less durable species for such uses which do not need permanence such as packaging or for other purposes where it will not be exposed to severe decay and borer attack (doors, furniture and mouldings) will help to conserve the more durable species for these uses where durability is the basic requirement such as railway ties, mine props and bridge timbers.

2. Evaluation and Performance of Preservatives and Treatment Processes

Siriban reported that untreated hard and soft portions of coconut wood in ground contact had an average life of 17.5 and 4.0 months, respectively. It was also noted that CCA-treated specimens failed due to decay and the untreated by termites.

All specimens treated by soaking and dipping were all destroyed from 12.33 to 4.5 months. Of these destroyed, specimens soaked overninght in PCP provided the best protection. It is interesting to note that the major cause of destruction was due to fungi among the treated and, for the untreated, termites did most of the damage. Based on the performance of the other perservatives, no definite relationship yet exists between the durability of treated outer and inner portions of the coconut trunk although the inner portion has a higher loading compared to the other portion.

Specimens, installed above ground, were still in good condition after 34 months of exposure. The untreated control were all destroyed after 18 months. The CCA and WCB specimens, treated by soaking, appeared to provide better protection than the PCP-treated specimens. The untreated (inner portion) specimens had an average life of 4 months.

When exposed to the weather but not in contact with the ground some protection is required. Pressure treatment with water-soluble preservatives such as copper-chromo-arsenate (CCA) and Copper-chrome-boron (CCB), to intermediate retention, 5 to 10 Kg/m3 of these commercial preservatives, gives excellent results. Brush-coating dry cocowood with creosote, copper naphthenate, or pentachlorophenol in diesel oil will give good protection but retreatment will be necessary every three to four years.

McQuire (1976) reported that coconut stem wood is not very susceptible to attack by wood boring insects and will give good service without treatment if it is protected from the weather. If guaranteed protection from insects is required it can be treated readily with boron by diffusion.

Debarking round poles and posts is an extremely difficult task but it is necessary if they are to be treated by conventional pressure or hot-and-cold bath method. Unless sophisticated treating plant capable of boiling-under-vacuum (Boultonizing) or steaming-and-vacuum is available, the wood must be at least partially air-dried before treatment and this must be done under cover. It was reported by Mosteiro and Siriban (1976) that when the outer zones are well dried adequate retention (272-329 Kg/m3) and distribution can be attained with creosote by hot-and-cold bath. Palomar and Sulc (1980) obtained a retention of 14.50 - 17.9 Kg/m3 copper-chrome-arsenate in round coconut poles and posts by vacuum/pressure.

Non-pressure treatments on air-dried coconut lumber (30% average moisture content) representing three density groups (hard, medium and soft) conducted by Siriban and Pabuayon (1984) reported that materials dipped in PCP for 30 minutes showed that the hard, medium and soft portions have an average solution retention of 221 Kg/m2, 303 kg/m3 and 530 Kg/m3, respectively.

The samples that were soaked overnight in 5% CCA had an average solution retention of 616 Kg/m3 and 429 kg/m3 for the soft density and medium density respectively.

An average solution retention of 564 kg/m3 was attained by soaking the soft density in B-B and the hard density obtained an average 214 kg/m3 average retention. Similarly, 401 kg/m3 was obtained in the medium density.

Brushing treatment with 5% PCP using one, two, and three coats as treatment variables, attained average absorptions of 303 Kg/m3 262 kg/m3 and 221 kg/m3, respectively.

The absorption in all the treatment methods meet the minimum absorption requirement of 200 kg/m3 to give adequate protection for indoor conditions.

Pressure sap displacement is an atractive method for treating freshly felled, unbarked logs and it appears possible to achieve a satisfactory retention and distribution of water-borne preservative by this system. It is difficult to obtain a leak-free seal with caps or straps but a simple method using pipes in pre-drilled holes overcomes this problem and apparently gives a good distribution throughout the interconnecting vascular bundles.

Palomar (1978) reported on the treatment of coconut trunks for electric power/telecommunications poles and fence posts. Three methods of preservative treatment were used, namely: vacuum/pressure (Bethel process) treatment for seasoned materials; pressure sap displacement for freshly-cut materials; and hot-and-cold bath treatment in water-borne preservative for seasoned and unseasoned materials. The first two used copper-chrome-arsenate (CCA) solutions and chrome-arsenate solution for cold-bath.

Satisfactory results were obtained from these studies: an average dry salt retention (ADSR) of 17.1 kg/m3 for poles and posts treated by the full-cell process using 30 minutes vacuum at - 85 KPa and 120 minutes pressure period at 1400 KPa and a final 10 minutes vacuum at - 85 KPa. For the same schedule of treatment the ADSR obtained for sawn and quarter posts was 18.3 kg/m3.

For the sap displacement technique, it appeared that penetration of preservative was satisfactory from 5 hours and 30 mins. pressure of 800 KPa using 10 per cent CCA solution. Spot inspection revealed patchy

to complete penetration of preservative both in the outer and inner zones of the stem. For hot-and-cold bath technique, an ADSR of 16.8 kg/m3 was attained for six hours hot bath of 12 per cent copper - sulphate solution and overnight cooling, before soaking for another 24 hours in a cold bath of 12 per cent chrome-arsenate solution.

Hot-and-cold bath treatment of coconut poles and sawn coconut timber in creosote was reported by Mosteiro, Casin and Siriban (1976). The coconut poles were hot-bathed from 8-10 hours at an average temperature of 96ºC and allowed to cool overnight approximately 10 - 12 hours, while the sawn coconut timber was hot-bathed for 6 hours at the same temperature and also allowed to cool overnight for the same period. The retention obtained from the round poles ranged from 115-173 kg/m3. In the sawn timber, the average retention of 330 kg/m3 was obtained from sawn pieces taken from the core and 272 kg/m3 from the outer portion. The recommended drying time is 4-6 weeks for sawn timber and 8-12 weeks for debarked round poles.

The high pressure sap displacement and hot-and-cold bath methods are adaptable to the rural areas due to their simplicity in operation and very low cost of investment. The vacuum/pressure method which requires high cost of investment is generally intended for commercial scale. However, the first two methods can be made to operate in commercial scale by setting up a battery of pressure sap displacement cap assemblies or installing large hot-and-cold bath tanks to accommodate more and longer poles or sawn timber.

Tests on the field and service performance of creosoted poles as reported by Mosteiro and Siriban (1976) showed that they were still in sound condition after six years of exposure. On CCA-treated poles, Sulc and Palomar (1980) noted then to be still in sound condition after four years in service.

Coconut wood like any wood burns easily and collapses under heat. Realizing the importance of this protection aspect, German, Siriban and Tamolang (1979) initiated fire-retardant treatment of coconut lumber.

A fire-tube test for determining the fire-resistance of untreated and treated coconut (Cocos nucifera L.) lumber was studied to improve its utilization for building construction. Result of test, ASTM Standard E69-50, indicated that a minimum dry salt retention of 48 Kg/m3 of Pyrolith M mono-basic ammonium phosphate on coconut lumber was effective in retarding the spread of fire. This retention provided protection which exceeded the acceptance criteria of the Basic Building Code (BBC) Building Officials Conference of American, Inc. (BOCAI), for fire-tube test of wood which provided maximum loss of weight of 20%.

Irrespective of the loadings, it was noted that the treated soft core takes more time to char compared to the outer portion. Charring is

more complete in some treated outer portions compared to the soft core at the same retention. As expected, the core had higher retentions. Residual glowing after burning lasted more in the untreated core compared to hard outer portion.

3. Properties and Types of Wood Preservatives

Properties

The most important attributes of a preservative are: it should be safe to use and handle, effective in protecting the wood, last for a long time, and be cheap. Other properties such as colour, compatibility with paints and finishes, corrosiveness, and ease of being impregnated into the wood to an appreciable depth are considered in the choice of a preservative for specific end-uses. However, no single preservative possesses all these properties.

Types of Wood Preservatives

Wood preservatives are generally classified into three categories:

1. Tar oil preservatives
2. Organic solvent preservatives
3. Water-borne preservatives

Tar Oil Preservatives

This can be derived from coal, peat, shale or wood, but the most important tar oil is coal-tar creosote or simply creosote. Creosote is a brownish-black oily liquid that comes from the tar produced during the carbonization or coking of bituminous coal.

Creosote is used either alone or in combination with coal-tar or as a creosote-petroleum solution.

Creosote because of its properties is not normally used in some applications. For example, creosoted wood is not used for food containers or inside buildings because it omits odors which affect the taste of fruit or dairy products. The volatile fractions are toxic to plants such that creosoted wood is not suitable for seed boxes or green houses. It is also unsuitable for timbers which are to be painted or varnished. However, its widest application is for poles, posts, railway ties and marine pilings.

Organic Solvent Preservatives

These preservatives consist of active chemicals as fungicide and/or insecticide dissolved in petroleum distillates, such as kerosene, diesel oil, number oil or special oils.

Pentachlorophenol (PCP) is a crystalline chemical compound (C_6Cl_5OH), formed by the reaction of chlorine or phenol. It is the most

important and widely used fungicide for organic solvent preservative. It is normally carried in petroleum such as diesel oil, kerosene or other low or high petroleum derivatives at five per cent concentration. The heavy oils remain for a long time and do not provide clean and paintable surfaces. Like coal-tar creosote, pentachlorophenol solution is usually applied in the treatment of wood for exterior use. However, when the color or texture of the coconut lumber has to be maintained, PCP in light volatile oils offers the best solvent/preservative system.

Other oil-based preservatives are the organo-metallic compounds containing mercury, copper, tin and zinc. The most widely used now are: solubilized copper-8-quinolinolate, copper naphthenate and TBTO (Tributyl tin oxide).

Water-borne Preservatives

This type of wood preservative has several advantages because water as a solvent is cheap and readily available. It also penetrates wood well and is free from fire, explosion, and health hazards. However, treated wood swells upon treatment, requires redrying for most purposes and shrinks upon drying. Because of their solubility in water most preservatives of this kind are subject to leaching from the treated wood whenever it is in contact with wet soil or water. Proprietary preservatives have been developed that are resistant to leaching. Generally preservatives of this type contain salts of two or more of the following elements copper, chromium, arsenic, boron compounds and zinc.

Copper-chrome-arsenate (CCA) is the most widely used water-soluble preservation. This is sold in the market as Tanalith CCA-Type C, Boliden K-33 or Celcure AP, Osmose K-33, Wolman CCA-Type C, or Stomite CCA-85. Copper-chrome-arsenate is now preferred to and more widely accepted than coal-tar creosote/pentachlorophenol due to its inherent capacity to leave the wood clean, paintable and free from objectionable odour after treatment. Since coal-tar creosote solutions and pentachlorophenol are oil-based they are now (1985) more costly than water-borne preservatives due to the increasing cost of oil.

Copper-Chrome-Boron (CCB)

These preservatives like the CCA-types are highly soluble in water. They are marketed as Impralit CKB and Wolmanit CB.

4. Preparing Timber Prior to Treatment

All coconut timber to be treated must be free from bark except those to be treated by sap-displacement to attain satisfactory treatment and good performance thereafter. Sawn timber from freshly felled coconut stems can be treated with water-borne preservative by diffusion. The high moisture content of the wood permits free movement of the solution into the wood. However, for other methods of treatment drying before treatment is essential. Drying the material before treatment permits adequate penetration and uniform distribution, and reduces risks of checking and collapse that would expose untreated interior portions after treatment. Good penetration of preservatives can be attained for coconut wood with moisture contents of not more than 35 per cent.

However, freshly cut coconut timber with moisture as high as 100% and 230% from the outer and inner portions respectively, can be treated by steeping in water-borne preservative.

It is also of great importance that all machining should be done prior to treatment such as planing cutting, framing and boring. Machining after treatment will either expose the untreated interior of the commodity or reduce the protective zone. There is also a risk of pollution from the sawdust and shavings. An advantage of machining prior to treatment is that the preservative penetrates deeply into the drilled holes and joints thus giving added protection to the areas most susceptible to decay and insect attack. When cutting or drilling of treated timber is unavoidable, it is necessary to swab liberally all exposed surfaces with a suitable preservative liquid.

Debarking of round coconut timber should be done to accelerate drying. Experience and actual experiments showed that the bark as reported by Laxamana (1983) in Quezon, Luzon greatly retards moisture removal from the inner zone of the log thereby prolonging drying time which can cause decay and insect infestations to the log. Debarked poles attained an average final moisture range of 40% to 80% at the end of 15 month exposure and unbarked poles were dried from an initial average moisture content of 150-175% to a final moisture of 85-100% within the same period of time. In College, Laguna, the drying time is 2-2 1/2 months for sawn timber 4-5 months for debarked round timber. Under Zamboanga conditions, it takes three to four months air drying of debarked round coconut timber to ensure good preservative treatment.

Prophylactic Treatments

Coconut timber is very susceptible to staining and decaying fungi and to termite attack. After felling, the trunks are seldom transported immediately to the processing plant but are left in the area for several days. During this period, staining and decaying organisms might have already infested the materials.

Considering the situation, it is advisable that felled trunks with bark be brushed or sprayed with suitable preservative solution at their ends. Similarly, if trunks are already debarked, a similar treatment must also be applied at the ends and on all surfaces of the trunks to prevent incipient deterioration during storage. Where the rate of felling exceeds the rate of processing and when timber qualities might be affected by organic deteriorating agencies during prolonged storage, prophylactic treatment is deemed necessary. This does not only maintain the sound condition of the timber but also helps maximize utilization.

Once processed into the form in which it will be dried, the wood should be given another prophylactic treatment with a good fungicide. Dipping is preferable to spraying, but if spraying is the only alternative, a complete coverage should be ensured.

Drying stacks should be erected with care:

a) The site should be elevated, free draining, clear of vegetation and open to sun and wind.

b) Bearers should be of concrete or adequately treated wood, and should be at least 500 mm high. The covers should extend beyond the stack in all directions, to a distance equal to at least one fourth of the stack height.

c) The timber should be open stacked using treated fillets or, in the case of posts, in the form of an open crib so that air can move freely.

d) Stacks should be marked to show the date of erection, and the material should remain in stack for a period of five to 24 weeks, dependent on whether it is sawn, quarter round or full round.

5. Preserving Processes

There are two general methods of preserving wood now in use: non-pressure processes which are applied without the use of artificial pressure, or pressure processes, in which the wood is placed in an impregnating cylinder or retort and impregnated with preservative under specified force pressure. This process requires high capital investment and highly skilled technicians to handle the operation and is unlikely to be adoptable to the rural areas where there is limited volume of material to be treated. The non-pressure processes which vary according to procedures and equipment used are suitable to the rural areas due to their simplicity in operation and low-cost capital outlay. Although the non-pressure processes generally provide inferior preservative retentions and penetration than the pressure processes, the former may occasionally be as effective as the latter in protecting the material from decay and/or boring insects.

The following information applies only to non-pressure processes. The treatment methods discussed here are based on the research and development efforts of Forest Products Research and Development Institute, NSTA, College, Laguna and the PCA-Zamboanga Research Centre.

Brushing

This is the simplest method of applying preservative into the wood. A minimum of 5 percent pentachlorophenol or 5 percent copper-chrome-arsenate (CCA) or Copper-chrome-boron(CCB) can be used in the treatment or air seasoned coconut wood. For partially dried wood use eight percent CCA or CCB. One to three coatings may be applied, depending on the service exposure, i.e., indoors and outdoors but not in direct contact with the ground. In most cases, however, wood treated by this method is recommended for internal use only and is a practical method when the wood materials are already in place or installed.

Steeping

This process consists of submerging wood in a trough of water-borne preservative solution, and allowing it to soak for several days or even weeks, at atmospheric temperature, although more rapid penetration would

be obtained if it were heated. If treatment is done on seasoned lumber both the chemicals and the water get into the wood. In green lumber only a slight amount of water can penetrate in the wood such that absorption is taken place by the diffusion of the salts from the preservative solution into the inherent water in the wood. Uusually, absorption takes place during the first two or three days and continues at a decreasing rate for an indefinite period.

Well seasoned lumber is soaked in five percent CCA solution for one to eight hours depending on the portion of the stem and the intended use of the material. The seasoned soft portion requires one to three hours and the seasoned hard portion four to eight hours. Absorption is ususally slight and the extent of penetration ranges from 3-6 mm. Freshly or partially seasoned wood is soaked in 10% CCA or CCB solutions. Better penetration is obtained in green than seasoned wood especially if the former is close piled under a damp place after removing from the steeping tank where further diffusion takes place.

Diffusion Processes

This process involves dipping of green wood for 30 seconds in a high concentrate of water-soluble preservatives (20-40%) and then stacking the treated wood immediately in solid piles and covering with polyethelene sheets or air-tight compartment to prevent loss of moisture. This is kept for 14-21 days wherein the water-soluble preservative salts diffuse into the water of the green wood. Preservative retentions are within the range of 4-8 kg/m3.

Double-Diffusion

The purpose of this method is to form highly insoluble salts within the wood through the reaction between chemicals. This is done by soaking green wood in a 3-5% solution of copper sulphate for seven days or more, enough for the chemical to diffuse into the wood and then immersing it to another solution containing sodium dichromate at the same concentration and period. The latter chemical diffuses a precipitate toxic againts decay and is resistant to leaching.

A classical modification of the double-diffusion process using water-borne preservative, involves the heating of copper sulphate to about 80ºC and immersing the material for about 3 to 6 hours and cooling overnight before immersing in an equal mixture of cold sodium dichromate and arsenic pentoxide solution for one to two days. However, the copper sulphate solution is found to be highly corrosive to metal when its temperature is increased, hence non-corrosive material such as stainless steel should be used as treating tank.

Hot-and-Cold Bath

The hot-and-cold bath process involves the heating of coal-tar creosote-petroleum solution or pentachlorophenol in heavy petroleum

oil with the material totally submerged during the duration of the treatment. The wood is heated in the preservative in an open tank for several hours and then immediately submerged in a cold preservative for an equal time or longer. In some cases, the material is allowed to cool overnight. This saves handling and another tank for the cold bath. For well-seasoned coconut timber a hot bath of two to three hours followed by a cold bath of the same duration or more is apparently sufficient. However, much longer periods are recommended especially during heating, to ensure that the wood is adequately penetrated by the preservatives. During the hot bath of about 100ºC, the air in the wood expands and the moisture is forced out. In the cold bath, or overnight cooling, the air in the wood contracts thereby creating in the wood cells a partial vacuum. The preservative solution is pushed into the wood by atmospheric pressure.

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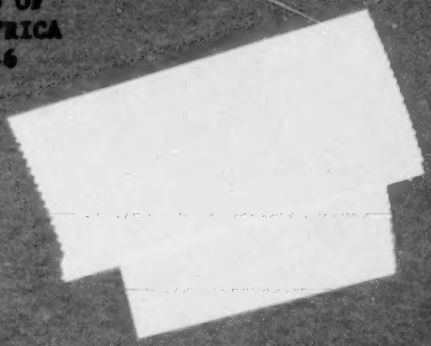
Distr.
LIMITED

UNIDO/IO.627
18 February 1986

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

MEETING OF INTERGOVERNMENTAL EXPERTS OF THE WHOLE ON INDUSTRIALIZATION IN AFRICA
Bujumbura, Burundi, 12-17 March 1986
Agenda item 5(a): Preparation and Promotion of Investment Projects



UNIDO'S PRE-INVESTMENT STUDIES PROGRAMME

Feasibility Studies*

Prepared by the
Feasibility Studies Section
Division of Industrial Operations

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I. INTRODUCTION

Investment is considered the central ingredient of industrialisation. Hence, Governments are keen on implementing measures and policies within their specific development objectives that would contribute to a high rate of investment. There are many factors influencing industrial investment among which domestic capacity to handle pre-investment and investment activities may be considered crucial. In many African countries the established institutions entrusted with the responsibility to map out industrial strategy, to prepare pre-investment studies and to implement industrial project, still require assistance to undertake these tasks. Accordingly, UNIDO has oriented its technical assistance programme to respond effectively to the needs of African countries in project identification, preparation, promotion and implementation.

It is an accepted principle that pre-investment studies are an indispensable pre-requisite to the investment decision. To minimise costs, project development goes through a number of inter-related stages. It starts with project identification. A project idea is then elaborated through a number of stages referred to as the project preparation cycle, i.e. opportunity study, support or functional study, pre-feasibility study and finally, the feasibility study. It is understood that only when a completed stage of the pre-investment work shows promising results, then the next stage is attempted. Project preparation, therefore, is a complicated task requiring highly skilled specialists in a variety of fields. Notwithstanding the value of a good pre-investment study, the UNIDO experience shows that often such studies are not up to the

standard required for investment decisions. It is sometimes the case that studies prepared by equipment suppliers perhaps free of charge, do not cover all aspects of the study, and tend to concentrate on the equipment and engineering requirements. These studies cannot be useful for evaluation by development finance institutes.
There are also cases where the pre-investment study is prepared by a consulting firm for a fee, but where the economic and financial aspects are either ignored or inadequately covered, or the study does not take into account the local conditions of the country where the project will function. Therefore, improving the quality of pre-investment studies should be an important concern of Governments.

In brief, the preparation of pre-investment studies is a necessity for the following reasons: (a) to avoid wasting domestic resources; (b) to enable Governments and individuals to reach rational investment decisions; (c) to attract internal and external financing, and (d) to facilitate the project's implementation. Needless to say, the funds expended on pre-investment studies are worthwhile even if the study should show a negative viability for the project. Development finance institutions have often complained about the shortage of bankable projects which means that good quality pre-investment studies are hard to find. This anomaly deserves to be examined by those concerned in each developing country and its causes identified and measures taken to deal with them.

The question of financing pre-investment studies has to be faced every time a project idea is identified. Such financing may be provided by the Government from its own funds, or by a financial institution, either domestic or international, which would eventually co-sponsor the project, or by an external source. UNIDO succeeded in convincing at least two bilateral donors to fund pre-investment studies on a selective basis. The funds are modest, but are a good start, and there are signs that other bilateral donors may also make contributions towards this activity.

II. THE PRE-INVESTMENT STUDIES PROGRAMME

This programme at UNIDO aims at achieving the important objective of building and strengthening national capacities either individually or collectively within the framework of self-reliance. This involves:

a) Raising the level of local skills by introducing and demonstrating the methodology and requirements for preparing feasibility studies in a comprehensive and balanced manner;

b) Establishing the required institutional infrastructure both at national and regional levels which will identify, formulate, evaluate and select industrial projects in terms of their technical and financial feasibility as well as economic and social benefits and costs;

c) Assisting developing countries in making the proper decision for the implementation of a specific industrial investment by undertaking or supervising the preparation of the pre-investment study.

UNIDO responds to Government requests for assistance in this field in a variety of modes as explained below.

1. Assistance in Project Identification, Preparation and Evaluation

The methodology for project preparation and evaluation is based on the Manual for the Preparation of Industrial Feasibility Studies which was published by UNIDO in 1978 and which has received wide acceptance. The Manual is practical in approach; it offers a single format and set of procedures which could be applied to a wide spectrum of industrial projects. Industrial development centres, industrial development banks and public and private consulting firms in developing countries should benefit especially from the Manual. The numerous individual experts assigned to project planning authorities in developing countries should also be able to take advantage of it.

UNIDO has a long experience in the preparation and evaluation of pre-investment studies and will continue to respond to Government requests for such assistance. The studies supervised by UNIDO are prepared with impartiality, confidentiality and highest standards and at reasonable cost. Moreover, UNIDO tries to involve local staff in the preparation in order to acquaint them with the methodology and concepts. Also an effort is usually made to recruit experts or consulting firms from developing countries to undertake the assignment where appropriate.

2. Assistance in the Application of the Computer model for Feasibility Analysis and Reporting (COMFAR)

In view of the wide application of the Manual for the Preparation of Industrial Feasibility Studies, UNIDO has developed a Computer Model for Feasibility Analysis and Reporting (COMFAR). The purpose of the COMFAR software is to facilitate and accelerate the computations required for the preparation and evaluation of financial statements, financial ratios, and rates of return for pre-feasibility and feasibility studies. Computer power allows repeated computations to analyse sensitivity risks involved and to determine possibilities of input substitution.

In order to assist countries to obtain and apply the COMFAR software, UNIDO developed a training programme. For the success of the training programme, it is indispensable that nationals should have the requisite background including thorough knowledge of the UNIDO Manual for the preparation of Industrial Feasibility Studies. The hardware consisting of a personal computer and related accessories may be obtained through UNIDO or directly by the client.

A brochure is available giving full details of this software programme.

3. Assistance in Strengthening National Capacities in Pre-investment Studies and Investment Follow-up

The setting up of a National Industrial Advisory Service attached to the appropriate substantive Ministry is a desirable step to be taken by

each African country even though it will take some time to build its capacity fully. The Advisory Service would consist of a nucleus of local specialists who would be complemented by drawing on international experts. UNIDO has been assisting countries in Africa in setting up advisory services or project planning units which have been tailored to the country's particular needs. Such assistance usually takes the form of a team of experts composed of an Industrial Economist (Team Leader), Market and Financial Analysts, a Mechanical Engineer and other engineers whose specialisations will be determined by the specific needs of the country concerned. It is obvious that this type of assistance will enable countries to undertake pre-investment studies themselves and will provide on-the-job training and will lay the foundation for a permanent institutional mechanism.

There is a case for this kind of service to be set up on a regional basis as well as to serve a number of neighbouring countries. The regional facility could undertake consultancy and advisory services at the request of member countries for a fee and in some cases free of charge, depending on the financial ability of the beneficiary country. it could also undertake training activities and encourage the formation and strengthening of counterpart local units in the member countries with which it would maintain a working relationship aimed at decentralising certain functions and activities. An additional merit of a regional organisation is that it could serve to promote regional industrial planning and co-operation.

A brochure is available outlining details of the type of assistance to be provided by UNIDO to set up industrial advisory units.

4. Assistance to Upgrade National Capabilities in Pre-investment Studies and Investment Follow-up

The shortage of trained manpower in many African countries has been a major handicap in the preparation of pre-investment studies. This poses a serous constraint to the process of industrialisation. It has been clearly recognised that the ability of a country to raise its rate of

industrial investment depends on its capacity to design and promote viable projects. In the long run, training policies should aim at achieving self-sufficiency in meeting training requirements, preferably at the national level. For the short run, co-operation among developing countries as well as international co-operation in this domain is a necessary option.

In response to the acute needs of developing countries for upgrading of skills in the preparation of pre-investment studies, UNIDO has been organising programmes at the national, regional and inter-regional levels during the past 15 years. These programmes are designed to provide economists and engineers in a relatively short time (from 2 to 8 weeks) with the necessary knowledge, both theoretical and practical, in advanced methods and techniques of project preparation, evaluation, financing and promotion.

A brochure is available outling the seminar programme and giving details about the lectures, duration and contents.

5. Assistance in Project Implementation

Upon completion of a feasibility study, a decision to implement a viable project would entail the search for a financing institution and partners, the negotiations concerning technology and management contracts, marketing arrangemnts, tendering procedures and engineering design and supervision contracts, etc. UNIDO can provide technical assistance in all these arrangements.

6. Publications

The following publications are available for distribution to member countries upon request:

- Manual for the Preparation of Industrial Feasibility Studies;
  covers project preparation and financial evaluation (ID/206), available in Chinese, Czech, Dahri, English, French, German, Hungarian, Russian, Spanish and Turkish. Burmese, Polish and Arabic under preparation.

- Guidelines for Project Evaluation (ID/SER.H/2) and Guide to Practical Project Appraisal (ID/SER.H/3) deal with socio-economic evaluation, available in English, French Spanish.

- Manual for Evaluation of Industrial Projects (ID/244) presents a methodlogy based on national value-added concepts and is applicable to all developing counties. Available in English, French and Spanish.

III. RECOMMENDATIONS

A. For UNIDO Action

Financing has always been a factor limiting both the quantity and quality of pre-investment studies. The Meeting may consider requesting UNIDO to set up a special purpose fund to conduct pre-investment studies. Developed countries would be urged to contribute convertible currencies to the fund and developing countries would contribute local currencies to meet local costs. Only when this fund receives international support will it operate on firm grounds, thus contributing effectively to the constant flow of viable projects which could be promoted and implemented. The Meeting could decide on a target level for this fund, taking into account the dimensions of the work to be done. The contribution of African countries to this fund, even though in local currencies, will be an important factor in the success of the fund.

B. For Country Action or Regional Action

1. Countries should take action to strengthen and/or establish industrial advisory services which will be entrusted with the task of identifying, preparing, evaluating, promoting and implementing projects. The required local staffing for the advisory service may be strengthened by drawing on foreign expertise in the initial years of operation.

The advisory service should establish co-operation arrangements with the local industrial community, with national and regional institutes having similar objectives, including development finance institutions and with international organisations, such as the World Bank, UNIDO and UNDP.

2. Countries should strive to upgrade local skills in this field through organising ad hoc training programmes and through the strengthening of local training institutes, with the assistance of UNIDO.